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EFFECTS BASED OPERATIONS AND TRANSITION ENGINEERING

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13. ABSTRACT *(Maximum 200 Words)*
This paper explores the use of AFRL-developed Effects Based Operations War Planning Tools for Air Force Modernization Planning. We conclude that these tools can provide a valuable analysis capability and insight for not only understanding the relationships between systems in accomplishing tasked actions, but also providing the modernization planner a means to conduct Modernization CONOPS based analysis to identify the needed non-trivial few investments for maximizing future warfighting capability.

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1.1 INTRODUCTION:

General John Jumper said, early in his tour as the Air Force Chief of Staff (CSAF), "In addition to the inherent operational benefits of defining how we will respond to given scenarios, these Task Force Concept of Operations (CONOPS) also serve as the focus for transforming our planning, programming, budgeting, requirements and acquisition processes. By beginning with our desired warfighting effect and then moving to the capabilities we need to achieve those effects, we are well positioned to prioritize our resources against the programs that best support the required capability." This statement is, in effect, a "Commander's Intent" for United States Air Force (USAF) modernization. It provides: the what--transform our planning, programming, budgeting, requirements, and acquisition processes; the how--begin with our desired war fighting effect and then move to the capabilities we need to achieve those effects, and the why--prioritize our resources against the programs that best support the required capability. Since this time period in late 2001 to early 2002 the Joint Staff and Services have made steady progress in defining a Capability Based Modernization Process.

The Joint Staff has published CJCSI 3170.01C Joint Capabilities Integration and Development System (JCIDS) that defines the Joint Capabilities Requirements Process, the Joint Concept Development Plan that describes how concepts will be used to define the effects necessary to achieve objectives and CJCSI 3010.02A Joint Vision Master Plan that defines a process that will translate emerging joint operational concepts into joint warfighting recommendations. They have also made excellent progress in developing the supporting Joint Operations Concepts (JOpsC), Joint Functional Concepts (JFC) and Joint Integrating Concepts (JIC). The USAF, in turn, has published AF Instruction 10-601, Capabilities Based Requirements Development, interim AF Instruction 63-101, Operation of the Capabilities Based Acquisition System and AF Instruction 99-103 Capabilities Based Test and Evaluation. The USAF also has the lead for the Global Strike Joint Integrating Concept (GSJIC).

The above Modernization Concepts provide the operational "context" for setting up the capabilities based modernization and Effects Based Operations (EBO) tools. These modernization CONOPS provide the who, what, where, when, and why context for capabilities based modernization analysis. One of the most important components of a new process is a concise and clearly understood lexicon of terms that are consistently and accurately used for implementing the process. The CSAF uses two key words, capability and effect that must be precisely defined in a capabilities lexicon. For the purposes of this paper, we will use the following definitions for capability, task and effect, as defined by Dr. Maris McCrabb:

1) <u>Capability</u>–the integrated set of end-to-end activities consisting of people, processes, and technologies necessary to perform a task to achieve an effect;

2) Task–action to be done. It is a discrete, definable, and bounded event. Combined with a purpose or rationale, it constitutes a mission. A task has both a measure and an indicator. An operational task consists solely of an objective (state of the world), a desired effect, and an object;

3) Effect–result or outcome of an action. An effect has both a measure and an indicator;

4) Measure–used to establish effect/result/outcome standards based on mission requirements

5) Indicator–observable or unobservable manifestation of action, cause, or result. A measure states what is to be looked for; an indicator is the evidence. [1]

The next section provides an analysis of EBO theory and how it can be applied to Joint and Service Modernization CONOPS and Capabilities Based Modernization Planning by using the GSJIC as an illustration.

1.2 EBO BACKGROUND

Brigadier General David A. Deptula states that effects-based operations will have "significant implications for how we fight in the future, how we will define success in warfare and--perhaps most important of all--the nature and type of forces that we must field to deal with emerging and future threats to our national security interests. It also has very significant implications for the mix of aerospace, land, and sea forces for the future."

When we look at using EBO for force modernization, we should be careful to use EBO to assist in defining the tasks to achieve the desired effects, and the capabilities we need to perform these tasks. In a briefing by Headquarters Air Combat Command on the Effects Based Operations Flight Plan, Major Reginald Williams states "EBO enables the focus of national security actions in a fashion that highlights capabilities required to achieve desired outcomes." [2] Indeed, we can set up a simple construct:

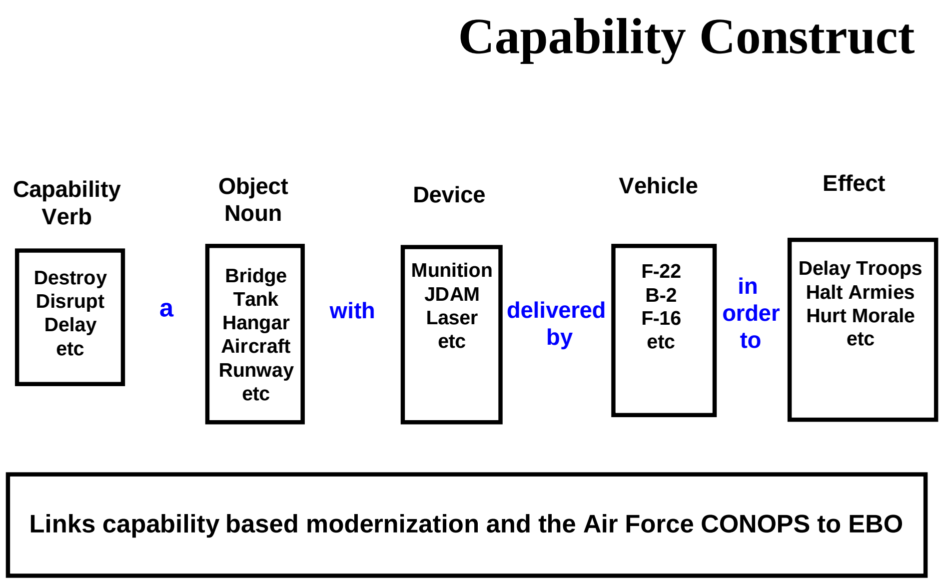

Figure 1. Capability Construct

Figure 1 above is read: have the capability to perform an action on an object with some device delivered by some vehicle in order to achieve the desired effect. When thinking in this manner, we can link the Modernization CONOPS to EBO, since capabilities are how we perform the tasks to achieve the effects. Thus, capability based planning tells us what we need to do, and EBO tells us why we need to do it.

The EBO tools that we will investigate for utility in modernization planning are dynamic. However, for this paper, we will restrict ourselves to the systems approach. According to McCrabb: "Effects theory rests on three important ideas: The first is taking a system approach to understanding the entity of concern. The second is modeling both the direct elements in the system of interest and the interactions between those elements. Finally, effects theory considers how a system might react to a force put against one or more of those elements."[3] We will not address the much more difficult aspects of EBO, in the cognitive sense of affecting human behavior. According to McCrabb "Clausewitz taught that the difference between real war and war on paper is that real war is fought against a human intelligence that reacts."[4] Both McCrabb and Paul Davis of RAND discuss the human intelligence as part of a Complex Adaptive System; the agility of human intelligence makes predictions of effects on human behavior much more difficult than effects on systems.

1.3 UTILITY OF THE MODERNIZATION CONOPS

The CSAF in his Capabilities Based Modernization "Commander's Intent" stated that CONOPS serve as the focus for transforming our planning, programming and budgeting, requirements, and acquisition processes. These Modernization CONOPS, such as the Air Force developed GSJIC, provide the who, what, where, when, and why operational "context" for setting up the capabilities based modernization and EBO Tools analysis. The GSJIC is the conceptual "seize the initiative" phase of 2015 joint operations attack of high value/payoff targets to gain and maintain access for follow-on operations. It is focused on achieving the following effects within the first 10 days of a major combat operations (MCO) campaign:

- Freedom to operate and freedom from attack (gain and maintain operational access)
- Enemy's will or capabilities significantly reduced
- Conditions set for decisive operations

Achieving these effects is dependent on the effective execution of the following tasks at the time and place of the JFC choosing:

- Posture forces (forces and facilities)
- Position forces to engage (maneuver)
- Engage Weapons of Mass Destruction (WMD)/Weapons of Mass Effect (WME) production, storage, and delivery targets
- Neutralize WMD active agents
- Engage moving maritime targets
- Engage airborne targets
- Engage hard and deeply buried targets (destroy or functionally disable)
- Engage leadership targets
- Attack computer networks and other input/output (IO) targets
- Deceive, disrupt, deny, degrade, and destroy (D5) anti-access capabilities
- Recover and regenerate forces

The most important elements of the Modernization CONOPS are the above effects and tasks that were developed to guide modernization planning. Tasks can be divided into two categories. "Direct effect" tasks, such as "D5 anti-access capabilities," are those tasks that when accomplished are in the "causal" linkage for achieving the CONOPS defined "freedom to operate and freedom from attack" warfighting effect on the opposing force. Functional tasks, on the other hand, are supporting components of the chain of events that lead to completion of the "direct effect" task. We found, however, that these CONOPS identified effects and tasks are insufficient at this point for setting up the EBO analysis. Additional detail is needed on the location, environmental conditions, people, process & technical means. This additional detail can be provided by operational vignettes (i.e., scenarios) that articulate the employment concept, technologies and conditions that could be used to achieve the GSJIC Task completion. As a result, in order for EBO based modernization planning to work one should start with the CONOPS and then determine the direct effect actions/tasks and operational conditions that are the "common reference points" used to determine the value or effectiveness of supporting functional tasks. These supporting functional tasks are components of an Operational Activity Model's Operational View Level 5 (OV-5)[5] description of the actions required to accomplish the "direct effect" tasks.

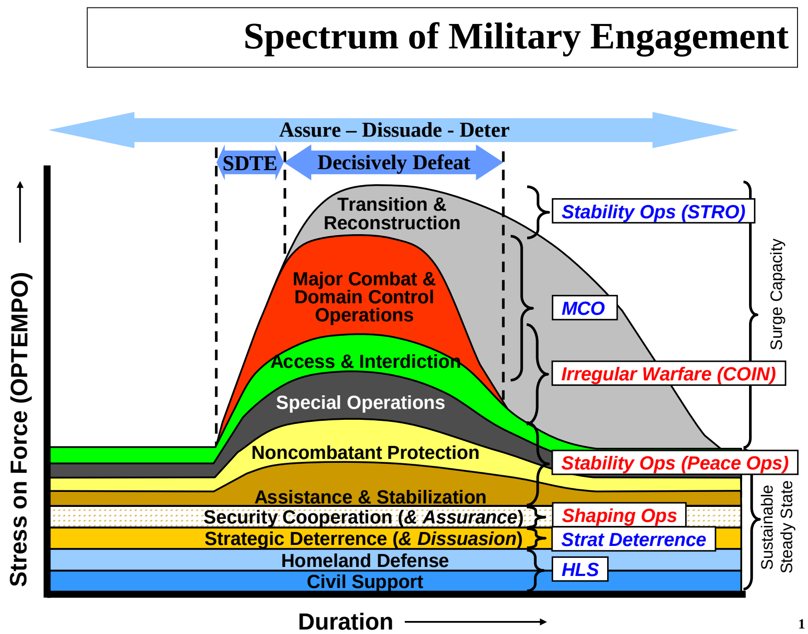

Figure 2. Spectrum of Military Engagement

Although this paper used GSJIC for our analysis, Modernization Planning will require a range of operational vignettes that cover the spectrum of military engagement in Figure 2.[6]

1.4 EBO TOOLS:

The Air Force Research Laboratory Information Directorate (AFRL/IF) is developing software tools to assist the warfighter in quantifying EBO. Two such tools that have been developed are the Strategy Development Tool (SDT) and the Operational Assessment Tool (OAT). Newer and enhanced versions of the OAT are the Causal Analysis Tool (CAT) and the Joint Causal

Analysis Tool (JCAT) which are in development. Both CAT and JCAT are considered government off the shelf software.

The SDT, sponsored by AFRL/IF EBO Advanced Technology Demonstration (ATD) provides a suite of plan authoring and course of action (COA) analysis tools for joint air campaign planning. The SDT primarily supports mission analysis and COA development, the first two steps in the Joint Air Estimate Process (JAEP). It transcends the capabilities of previous planning tools by using adversary models to guide decisions about desired effects and actions at multiple levels of planning. It also allows collaborative work by multiple users on the same plan.

The SDT's plan authoring tools use an effects-based plan representation for decomposing the Commander's Guidance into COAs, phases, objectives, effects, causal linkages, tasks and targets. The SDT is integrated with the following effects-based analysis tools to support the JAEP's third step, COA Analysis: [7]

- θ Blue (friendly forces) COAs may be analyzed with AFRL's OAT to determine the probability of achieving the objectives in the COA over time. [8]

- θ Adversary center of gravity (COG) models with blue interventions may be analyzed in the OAT to assess the impact on Red (enemy) systems.

OAT may be used during:

- θ Planning, to assess the probability of achieving blue objectives

- θ Execution, as a campaign assessment tool, to revise probability estimates based on combat assessment feedback from the intelligence, surveillance and reconnaissance assets.

OAT allows the commander and staff to graphically/visually represent a plan. The actions or states of a plan are joined by directed arcs called causal links, which indicate causal dependencies between the connected actions. Once a plan is created from the CONOPS with an associated OV-5 operational view, it can then be assessed to determine if it achieves the commander's intent. The user draws the actions and causal links in the OAT plan layout framework, and a Bayesian network calculates the probabilities. Bayes nets allow one to model uncertainties about the world and predict outcomes of interest leveraging any available evidence. In OAT, one captures causal relationships between actions and effects in a Bayes net that allow one to obtain the probabilities of these actions and effects over time.

1.5 USING EBO TOOLS FOR CAPABILITY BASED MODERNIZATION PLANNING ANALYSIS

Dr. McCrabb prepared a briefing dated February, 2004, entitled *Effects-Based Operations: Theory & Process*. We will use one of his charts to illustrate the linkage of EBO to Modernization.

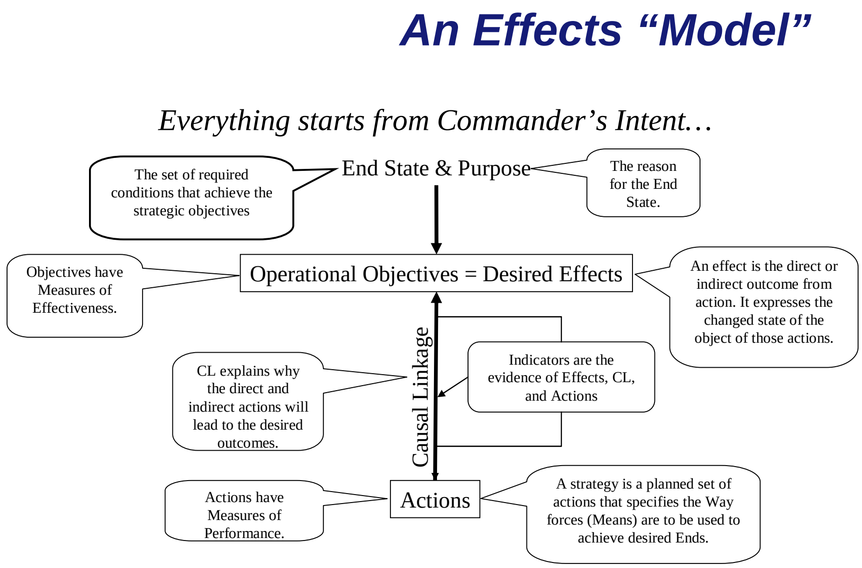

Figure 3. Effects Model

Thus, in figure 3 we start with the guidance, the commander's intent, and identify specific desired effects, then identify the tasks (the targets). EBO focuses on effects, not targets. Once an EBO architecture is set up, we can then focus on the capabilities needed to perform the tasks that achieve the effects. The first step is to set up an OV-5 activity model that depicts the sequence of events that must occur to produce a capability. This is sometimes referred to as the "kill chain". The desired capability is decomposed into the sequenced activities that must successfully occur. The higher order capability, in math-speak, is the dependent variable, and the lower order activities are the independent variables. For analysis, we can adjust the value of the independent variables and calculate the change in the dependent variable. We could adjust the value of an independent variable by, perhaps, force modernization, and then calculate if we have increased the desired capability—the dependent variable. As a very simple example, the capability to destroy a target (damage expectancy, or [DE]) depends on the probability of the weapon arriving at the target (PA) and the probability that it will damage the target (PD), given that it did arrive. Thus we could write

$$DE = f(PA, PD)$$

Figure 4. Damage Expectancy

In Figure 4, DE is the capability we are seeking. It is the dependent variable, and is a function of the independent variables PA and PD. We can further decompose the PD into its components, such as the explosive power of the weapon, which we will denote as yield, the accuracy of the weapon, which we will denote as CEP (circular error probable), and of course, the type of target we are hoping to damage.

PD = g(Yield, CEP, target type)

Figure 5. Probability of Damage

While PD is an independent variable in Figure 4, it is a dependent variable—capability objective—in Figure 5. Figure 6 is a visual display of DE and PD relationships:

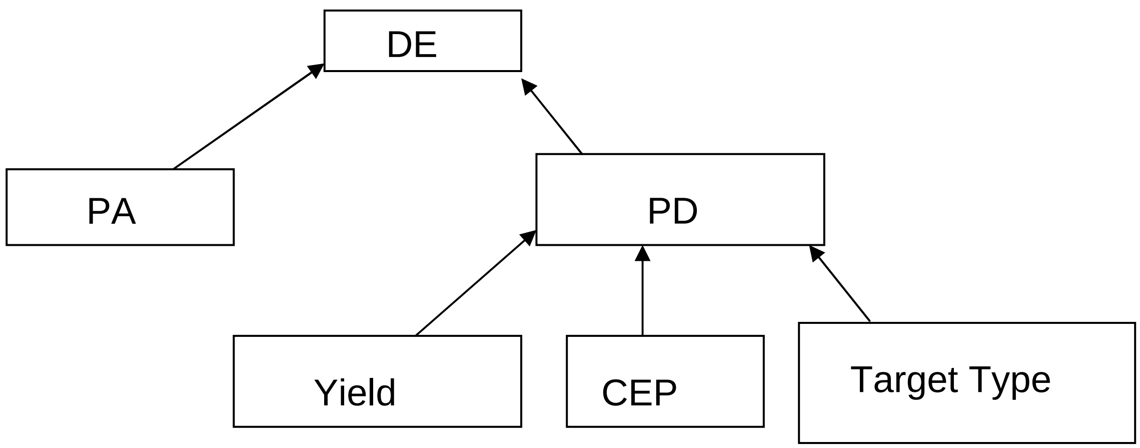

Figure 6. Damage Expectancy, Probability of Arrival & Probability of Destruction Relationship

Over the years we have developed the complete set of algorithms that are in the Joint Munitions Effectiveness Manual (JMEM) to calculate PD. For very many years our force modernization efforts focused on maximizing PD by developing the proper munitions for the various target types we determined we needed to have the capability to destroy. We developed laser guided bombs to destroy bridges, heat seeking munitions to attack tanks in battle, as well as weapons to destroy deeply buried bunkers, or cut runways. We will return to this concept later in this paper, since it is important to realize that we can build very useful algorithms to assist in force modernization and "fill the gaps" at any level of the EBO construct. EBO tells us the target type—why we want to destroy bridges, tanks, bunkers, or runways.

In Figure 6 above, we could have determined, through decomposition, from a higher order GSJIC effect we were trying to achieve, that we needed to destroy ground mobile surface to air missiles (SAM) to achieve the GSJIC "freedom to operate effect." We would then seek to determine our capability to do that (PD in Figure 6 for ground mobile SAMs as a target type). If we found that PD was lacking—we had a gap—then we would seek to develop the munitions needed to close the gap and achieve that capability. In the 1960's we determined that we needed to destroy bridges in Vietnam to achieve our desired effects on the enemy, but severely lacked that capability until the advent of laser guided weapons that were accurate enough to effectively drop the bridge support pillars.

If we use the Find, Fix, Target, Track, Engage, Assess (F2T2EA) construct as our higher order activity model, we would decompose each of these into its components. Figure 5 is a very small, but illustrative component of the "Engage" activity.

Now, the target may be a set of fixed targets, already well-known in terms of precise location and weapon required. In this case, we have already found the target, fixed it, will assign a weapon to it, and have no need to track it since it is fixed, and then we engage it and assess damage in terms of the effects we were trying to achieve. The simple model in Figure 6 was adequate for determining any weapon-target pairing gaps in damage probability. The other independent variable in the DE construct is PA, the capability to penetrate and arrive at the target. PA is on the same level as PD, and the agreed upon algorithm for DE—how DE behaves as a function of PA and PD is in Figure 7.

$$DE = PA \times PD$$

Figure 7. Damage Expectancy Algorithm

As the constructs become much more involved, it becomes much more difficult to determine the algorithm for the dependent variables. We will address this and a PA construct later, but for now we would like to point out that the PA capability requirement has been met over the years with Offensive Counterair (OCA), Defensive Counterair (DCA), and Suppression of Enemy Air Defenses (SEAD) as mission areas. OCA sought to destroy enemy aircraft on the ground to eliminate that threat to our aircraft. DCA sought to destroy enemy aircraft that were airborne. SEAD began with chaff in the 1940's, used the F-105 Wild Weasel in the 1960's, and today uses many methods to include the high-speed antiradiation missile.

Passive techniques to assist in the PA capability requirement have been low level penetration altitudes to avoid radars, electronic countermeasures (ECM) to jam radars, and now stealth to avoid detection and lock on. Flares have also been used in this role. Again, force modernization over the years has been done to fill capability gaps found at these levels.

Today, we have a new challenge—F2T2EA actions against moveable, relocatable, or moving targets in single digit minutes. [9]

1.6 AIR FORCE MODERNIZATION PLANNING

The Task Force CONOPS serves as the focus for modernization planning. Figure 8 lists the six AF Modernization CONOPS. Over the past few years the Air Force has been compiling capability requirements for the CONOPS, as well as a Master Capability List (MCL). Progress has been made in constructing the OV-5 activity models as well. The OV-5 activity model can be captured in the EBO tools we described to assist in analysis and determine if there are any gaps in the process. The probability of success for an activity can be measured and increased through modernization.

In the 28 February 2005 briefing by the Global Persistent Attack CONOPS Champion, Lt Col John Fyfe referred to the MCL version 5.5 as the most current. The MCL is the common language for use in capabilities-based planning. The goal of the MCL is to be mutually exclusive and collectively exhaustive. These capabilities are the things that a military does. How it is done has changed over the centuries, but the basic warfare capabilities employed by commanders are strikingly static. These basic tenets are captured in our military doctrine.

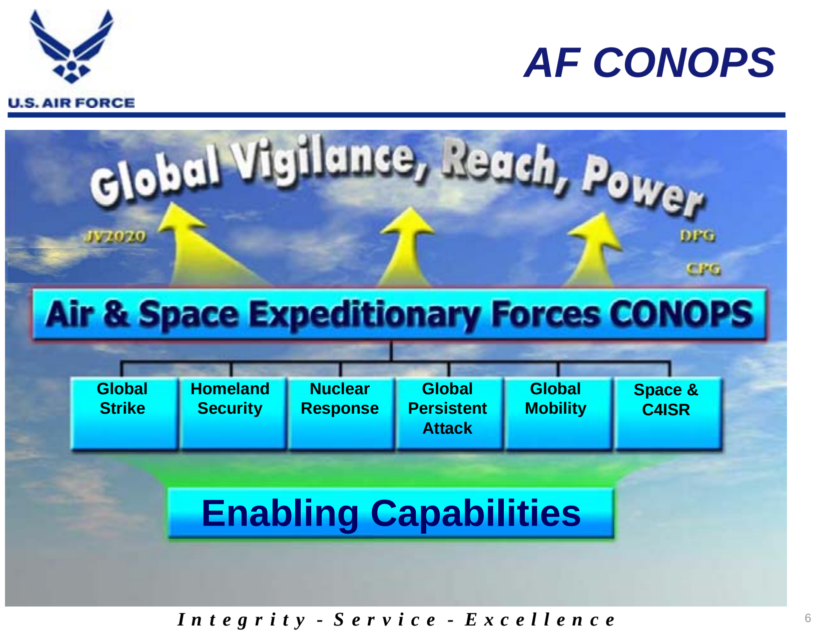

Figure 8. AF Modernization CONOPS

Each capability in the MCL has several characteristics associated with it. One is proficiency: how well can we execute the capability. We can evaluate proficiency at a point in time, for example, today or at the end of a modernization planning year cycle. We can also set a proficiency goal, called by Lt Col Fyfe a value threshold score: how well the Air Force should perform that capability measure of performance (MOP) to create the desired effect to support the warfighter. Currently the value threshold scores will be provided by the operational subject matter experts (SMEs) and the proficiency scores will be provided by the system SMEs. We believe that as the process matures, and the EBO tools capture the CONOPS processes and activities, these values can be honed by experimentation and captured in the models. According to Dr. Paul Davis of RAND, "Because the questions asked in EBO analysis are so different from traditional questions, a new base of empirical information should be vigorously pursued including that obtainable from history and from a combination of gaming, man-in-the-loop simulation, and experiments in battle laboratories or the field."

One important observation of the activity construct that leads up to creating the desired effect is there will be many variables that contribute to the desired effect. The size and complexity of the problem may seem overwhelming at first blush, but when the problem is dissected into its component parts—the sub-sub-sub…capabilities—we quickly find that there are the "trivial many" and the "non-trivial few". These are determined by the "so-what?" question. For example, maybe we can't "kill tanks under trees at night in the weather"—but so what? Is this an MCL capability for which we have a low proficiency, but has little or no need to successfully implement the Global Strike or Global Persistent Attack CONOPS? If it does have a significant impact because the commander's strategy calls for that tactic, then can we isolate that capability and devise programs to fill that gap?

A second characteristic for capabilities in the MCL is sufficiency: the age old question of "How much is enough?" If we can proficiently destroy a deep underground bunker, do we also have enough weapons to destroy all of the deep underground bunkers required to achieve our desire effect? That, of course, is scenario and policy dependent. Force sizing is usually dictated by policy like the scenarios in the Quadrennial Defense Review (QDR).

The ideal world would have the MCL with its current proficiency and desired value threshold for each capability well defined and "sitting on the shelf". The activity models are drawn for each CONOPS and the "on-shelf" capabilities are mapped to the activities. Over time, the proficiency scores will mature through additional insight and/or experimentation. Quick EBO models, like the ones referred to in this paper, can give an initial evaluation of the probability of achieving the desired effect with the chosen set of activities that constitute the operational concept. If the probability is too low, the activities can be altered to employ capabilities with higher proficiency values. This method is what we actually do for current operations—do the best you can with what you have! *For modernization planning, however, we want to determine the preferred course of action (COA) with the least risk, and then determine any capability shortfalls and what is needed to correct those shortfalls through the Joint Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) Analysis Process.*

1.7 A SIMPLE EXAMPLE

Figures 9 and 10 are a small portion of an activity model that would be found in both the Global Strike and Global Persistent Attack CONOPS to destroy moveable targets. Figure 9 dissects the capability to "arrive on target" (the value is calculated as a probability using a Bayes net in the JCAT). Before deciding to attack the target, one must first identify it. Figure 10 investigates several possible means of target detection using Unmanned Space Vehicles (USV), Unmanned Airborne Vehicles (UAV), Manned Airborne Vehicles (MAV), and Surface Vehicles with various sensors.

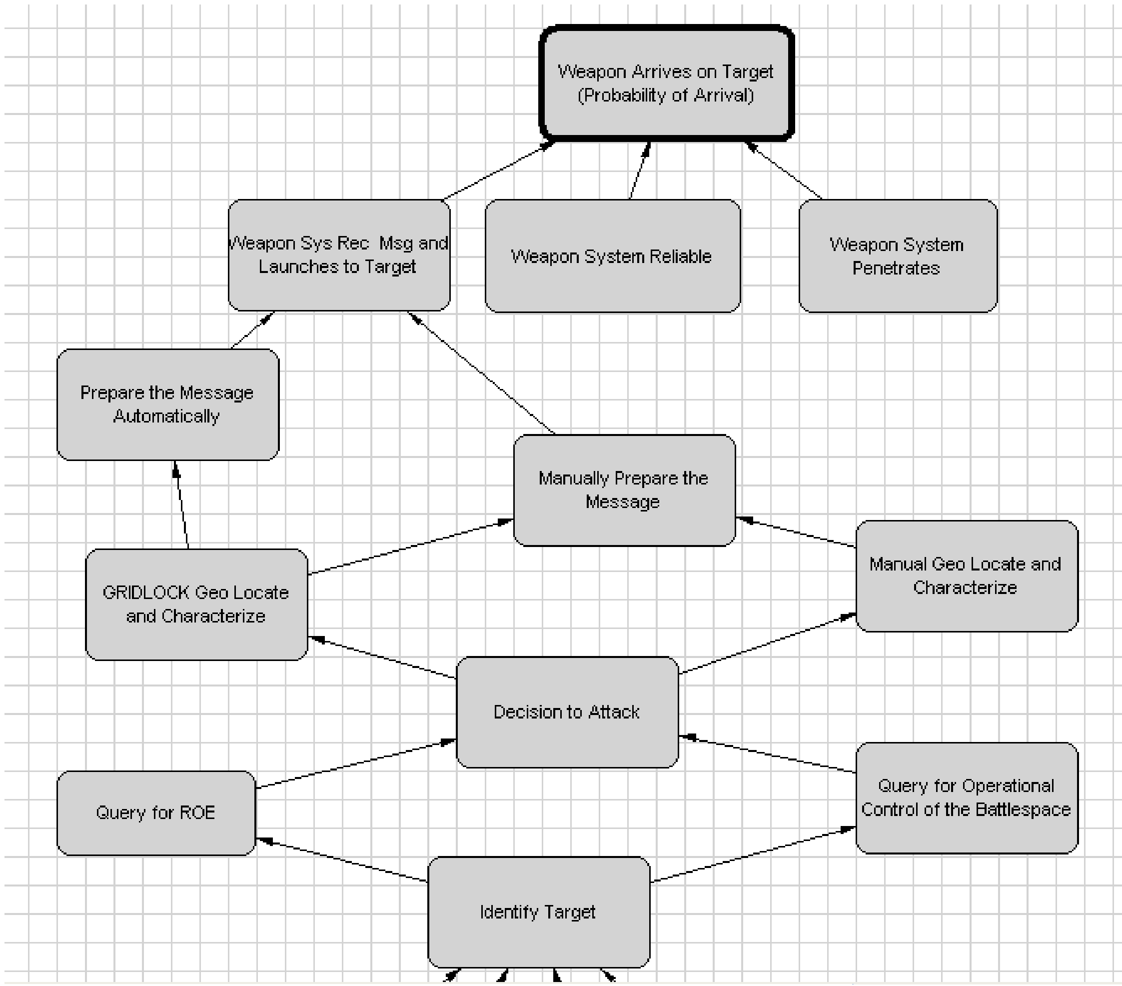

Figure 9. OAT/JCAT OV-5 example, factors affecting "arrive on target"

A systems engineer can calculate precisely the capability of a sensor-type on a vehicle-type to detect a target-type operating in a terrain-type. This is a matter of physics. Much more difficult, however, is to calculate the probability of correct identification, given detection. Even more difficult is calculating the probability of correct identification given detection by two separate sensors.

Figure 9 is what happens after a target is identified. We query the rules of engagement (ROE) and see if we have operational control of the battle space, and then decide to attack. We may have to manually geo-locate and prepare the message, or through modernization with automated geo-location, we may be able to do this automatically. It would probably take more time to do it manually, and for mobile targets, this may be the difference between success and failure. If we do not geo-locate, in order to launch-on-coordinates, we may not be able to use a stand-off weapon, and need to use the on-board systems to choose the aim point. This may reduce the penetration probability of success.

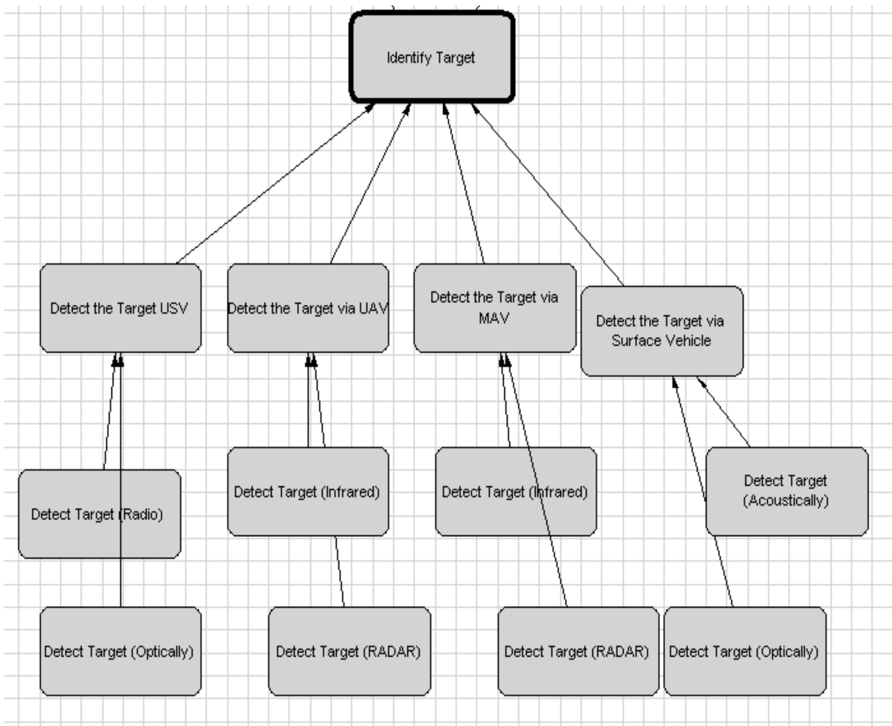

Figure 10. OAT/JCAT OV-5 example, finding & identifying the target

In Figure 9, the arrival probability depends on receipt of the message, the reliability of the weapon system, and the ability to penetrate to the target. Modernization may allow stand-off weapons if we can launch on coordinates, and until then we will need to rely on stealth, ECM, offensive/defensive counterair, and other tactics to have a high probability of success against mobile targets.

The Air Force Capstone Concept for Joint Operations (AFCCJO) talks about brilliant intelligence, surveillance and reconnaissance (ISR) sensors connected to a national signatures library providing on-the-fly target characterization and identification regardless of the enemy attempts to conceal the activity of the facility. The AFCCJO states that the Air Force will employ a variety of sensors (image, infrared, radar, signal, human, seismic, materials, spectral, radio frequency) to discover the location of the targets of interest. We can see in Figure 10 above that we are trying to identify a target after detection so that we can go on to eventually attacking it (Figure 9). The issue discussed above concerns dual phenomenology, or a mix of different sensors. If a target is detected with a single sensor, then assume the probability of a correct identification (a value score for proficiency) is 60%. Also assume that a second sensor that detects the same target has its stand alone probability of correct identification of 60%. What then is the probability of correct identification given detection by two different sensor types? Is it a simple compound damage expectancy algorithm, so that it would be 84%? Probably not! But is there any value in detection with two separate sensors? And, does it matter which types of sensors they are? We can devise experiments to determine the right answer, and also determine what mix of sensors is better. This would assist in our modernization planning efforts, since we want to pass the gate of “correct identification” in the kill chain by achieving the proficiency value threshold for the capability to correctly identify a target. This may be a combination of sensors, and we can find out through experimentation. Once we obtain these values, we can replace the values suggested by the SMEs with the observed values in the EBO models.

2.0 SUMMARY AND ASSESSMENT

First, modernization Concept of Operations (CONOPS) provide the who, what, where, when, and why operational context for setting up capabilities based modernization and Effects Based Operations (EBO) Tools analysis. The most important elements of the Modernization CONOPS are the effects and tasks that were developed to guide modernization planning. "Direct effect" tasks are those tasks that when accomplished are in the "causal" linkage for achieving the CONOPS defined warfighting effects on the opposing force. Functional tasks are the supporting components of the chain of events (activities) that lead to completion of the "direct effect" tasks.

Second, one must accurately, carefully and consistently apply EBO theory to modernization planning. Failing to do so leaves one facing a substantial risk of getting lost in an analytical "black hole" consisting of a nearly infinite "functional activity" analysis without any cross functional warfighting common purpose. These are the trivial many.

Third, we took a leap forward in postulating that we can use warfighting EBO Tools to assist in force modernization planning. We believe that these tools can provide a valuable analysis capability and insight for not only understanding the relationships between systems in accomplishing tasked actions; but also providing the modernization planner a means to conduct Modernization CONOPS based analysis to identify the needed non-trivial few investments for maximizing future warfighting capability. When we look at using EBO for force modernization, we caution that EBO be used to assist in defining the tasks to achieve the desired effects and the capabilities we need to perform these tasks and not to calculate a "force multiplier" for modernization planning.

Fourth, quick EBO models, like the ones referred to in this paper, can give an initial evaluation of the probability of achieving the desired effect with the chosen set of capabilities or activities that constitute the operational concept. The desired capability is decomposed into the sequenced activities that must successfully occur—the kill chain. The higher order capability, in math speak, is the dependent variable and the lower order activities are the independent variables. For analysis we can adjust the value of the independent variable and calculate the change in the dependent variable. We could, for example, adjust the value of an independent variable by force modernization, and then calculate if we have increased the desired capability—the dependent variable. If the probability is too low, the activities can be altered to employ the use of capabilities with higher proficiency values. As we find gaps through this systematic approach, suggested Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTMLPF) solutions can be applied to fill those gaps. We may alter the activity, or acquire new capabilities from available programs, or find we need to do research and development. The EBO tools can help identify the "non-trivial" few—the ones with the biggest "so-what?"—so we can then concentrate on: 1) getting the best data, whether by additional research or experimentation, and 2) filling the gap.

Finally, the constructs for the Master Capability List (MCL) and the activities for the CONOPS are maturing. The next steps are to map the activities for the CONOPS into the EBO Tools, and use them to calculate probability of success. The individual probability values can be initially inserted from subject matter expert (SME) inputs. The "non-trivial few" that drive the answers can be honed through experimentation, and then captured in the EBO Tools. As Dr. Paul Davis of RAND stated "Improvements will depend on developing an expanded and enriched empirical base. The next steps should include in-depth application of the principles and efforts to obtain insights and data from history, training, exercises, and experimentation (both in the laboratory and in the field)." The EBO tools will assist in determining which values we need better fidelity on, and therefore which experiments will have the highest payoff in terms of decisions for force modernization.

3.0 REFERENCES

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[1] Concept of Operations for Effects Based Operations Essay, Maris "Buster" McCrabb, 2/08/02

[2] Briefing by Major Reginald Williams, HQ ACC/XPS, Effects Based Operations Flight Plan

[3] *Explaining "Effects"* Maris "Buster" McCrabb, 6/22/2004, p29

[4] IBID.

[5] DOD Architecture Framework Version 1.0, Volume II: Product Descriptions, 2/9/04

[6] Capabilities Based Planning & Concepts Briefing, CDR Todd Kiefer, Joint Staff J-7, 22 Sept 2004

[7] We will return to this, since we want to determine if these tools can be used for Capabilities Based Modernization Analysis.

[8] If we change the Capabilities leading to the effect through modernization, we should be able to calculate the contribution to the objective. Since there will be a multitude of capabilities that will influence the objective, and also a multitude of modernization alternatives, we hope to determine the non-trivial few, as distinguished from the trivial many.

[9] The CSAF issued this challenge as an AF modernization goal.